TESTING OF WINDSENSORS AND THE USEFULNESS OF VIDEO TECHNOLOGY AT MARINE STATIONS

Author: Merete H. Larre et al
The Norwegian Meteorological Institute, Niels Henrik Abels vei 40, Box 43 Blindern, 0313 Oslo, Norway.
Tel. +4722963000, Fax. +4722963050, e-mail: merete.larre@met.no

Abstract:

At many lighthouses along the coast of Norway observations have been carried out by lighthouse keepers. Since most of the lighthouses now are unmanned, the Norwegian Meteorological Institute (met.no) has to find other solutions for observations along the coast.

Different types of windsensors are installed for comparison at a testfield at Stavernsodden lighthouse (south east coast of Norway). The data collection from the different windsensors started October 2002. Both cupanemometers and ultrasonic sensors are compared.

The test field also includes use of video technology for registration of visibility. Some visibility points are used to decide the visibility. The camera is preprogrammed to move to the visibility points.

Objectives

- To get experience regarding reliability of different windsensors.
- Enable selection of windsensor types that minimize maintenance, work and expenses.
- Evaluate the usefulness if video technology substituting observers.

The poster presents preliminary results.

Windsensors

Since the measurements are used for intercomparison of sensors and not as observation data, all wind sensors are installed at a 6 m high mast instead of normally 10 m above ground.

- 1 Vaisala WA15 (cupanemometer and wind vane)
- 1 Gill Windobserver (ultrasonic)
- 1 Vaisala WS 425 (ultrasonic)

As reference we use the Vaisala WA15 sensor since that is the mostly used sensor at the Norwegian AWS. For the Vaisala WS 425 sensor there is only 1 min. average data (1 min. data) available for the analysing period in this poster, but for the VaisalaWA15 and Gill sensors also 10 min. average data (10 min. data) are available. These 1 min. data are not so as good as the 10 min data for analysis, because ”noice” effect the results. The data are from August to December 2003.

Difference in wind speed

Gill Windobserver

Figure 1 shows the 24 hour average of the windspeed (based on 1 min. data) for the Vaisala WA15 sensor and the Gill sensor. Mostly it is few differences between the two sensors. A couple of times it seems like Gill isn’t reaching the same peaks as Vaisala WA15. This happens probably because Gill is in the shade of the other sensors at a few wind directions and is placed a bit lower than Vaisala WA15.

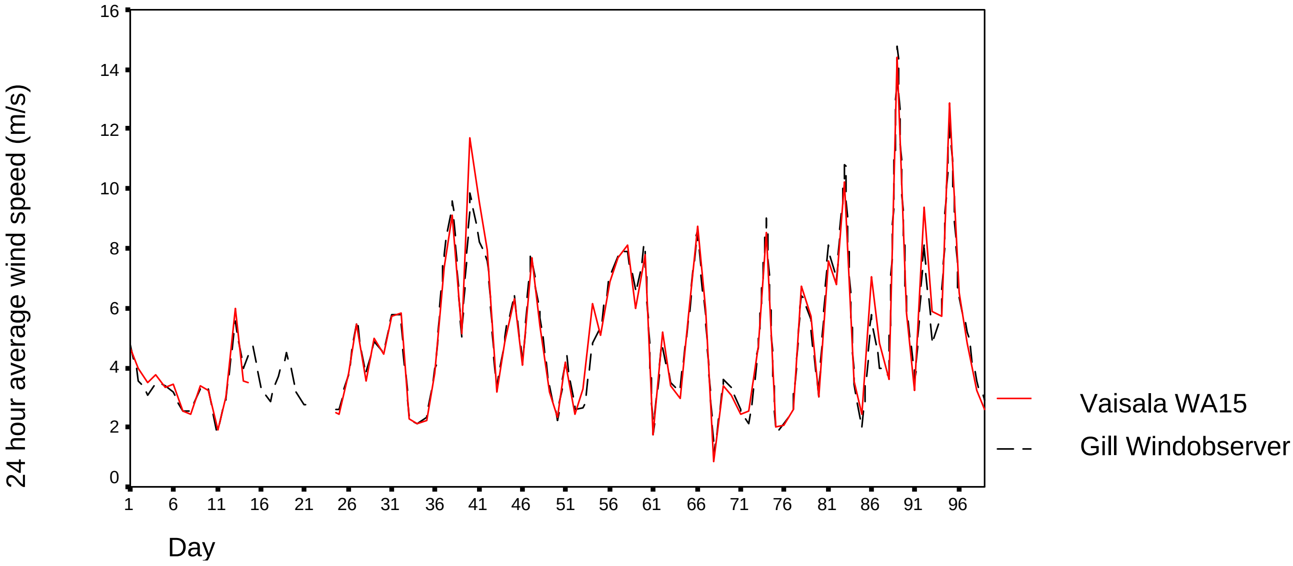


Figure 1: The 24 hour average of the wind speed for the Vaisala WA15 sensor and the Gill sensor based on 1 min. data (August – December 2003).

Table 1 shows the difference between Vaisala WA15 and Gill every month based on 10 min. data. The standard deviation is acceptable and the average values are close to zero. The total average is negativ (-0,06). This result suits well with the placement of the Gill sensor in the mast.

Table 1. Difference in wind speed between Gill and Vaisala WA15 (10 min.data)

Month	Number of measurements	Average	Minimum	Maximum	Standard deviation
August	25573	-0,10	-2,34	0,60	0,41
September	14422	-0,21	-3,56	0,97	0,89
October	20360	0,02	-2,59	0,80	0,52
November	14276	0,02	-2,85	1,37	0,59
December	40639	-0,07	-3,78	1,48	0,68
Total	**115270**	**-0,06**	**-3,78**	**1,48**	**0,63**

Since we only have 1 min. data available from the Vaisala WS 425 sensor, it is interesting to compare it with the 1 min. data from the Vaisala WA15 sensor and the Gill sensor too. Table 2 shows what the total values of the difference between Gill and Vaisala WA15 is, based on 1 min. data. Notice that the average is the same, but that the standard deviation is bigger as expected because of more "noice".

Table 2. Difference in windspeed between Gill and Vaisala WA15 (1 min data)

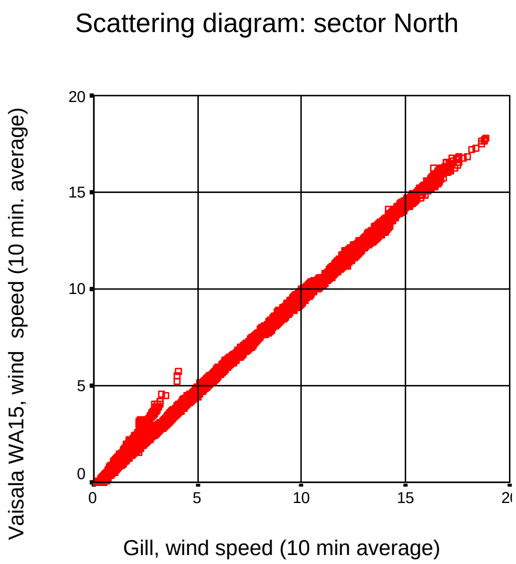
Month	Number of measurements	Average	Minimum	Maximum	Standard deviation
August-December (total)	**116742**	**-0,06**	**-11,16**	**11,50**	**0,99**

Table 3 shows the difference in windspeed between Gill and Vaisala WA15 at different wind directions (divided into 16 sectors at 22,5 degrees each) based on 10 min. data. Notice that the standard deviations are at a satisfying level, but that they are not so good for wind from east (E) and south west (SW-WSW). This is caused by how the Gill sensor is placed at the E-W pointing crossarm. The Gill sensor is placed in the shade of the other sensors and the buildings near by. Also notice that wind from north (NNW, N, NNE) gives lower standard deviation, because of less disturbances from that direction.

Table 3. Difference in wind speed between the Gill and Vaisala WA15 sensors for different sectors based on 10.min data in the period August-December 2003.

Sector	Number of measurements	Average	Minimum	Maximum	Standard deviation
N	19773	0,30	-1,67	1,14	0,15
NNE	18531	0,15	-2,19	0,62	0,15
NE	8701	-0,11	-2,31	0,77	0,33
ENE	8768	-0,51	-3,02	0,32	0,47
E	4020	-1,33	-3,56	0,34	1,10
ESE	2189	-0,23	-2,26	0,35	0,33
SE	1738	0,07	-2,30	0,57	0,28
SSE	3195	0,48	-1,60	1,37	0,36
S	3066	0,58	-2,90	1,48	0,43
SSW	7491	0,33	-2,98	1,30	0,38
SW	13036	-0,75	-3,78	1,04	0,59
WSW	3458	-1,02	-3,78	0,51	0,82
W	3618	-0,20	-2,50	0,51	0,31
WNW	7396	-0,13	-1,69	0,59	0,32
NW	5440	0,34	-1,49	0,99	0,22
NNW	6312	0,34	-1,18	0,95	0,18
TOTALT	**115270**	**-0,06**	**-3,78**	**1,48**	**0,63**

We have looked a bit closer at the ”best” direction (N) and the ”worst” direction (E). The scattering diagram in figure 2 shows that both the displacement and the scattering is small for wind from north (except for a few measurements for wind under 5 m/s). For wind from east there is much more scattering and a marked displacement.



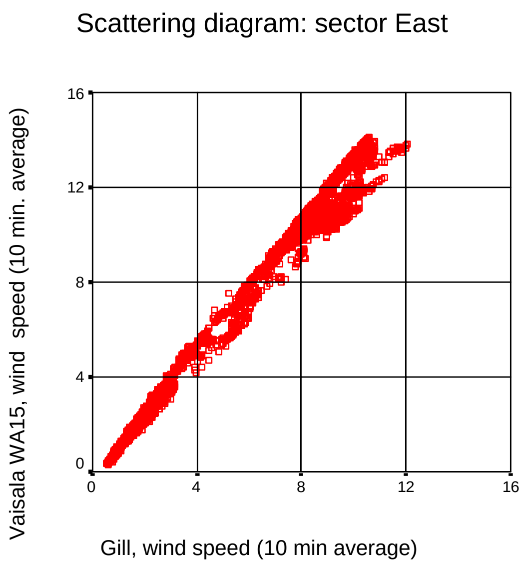


Figure 2: Scattering diagram for the Gill sensor and the Vaisala WA15 sensor based on 10 min data from sector North (N) and East (E) for the period August - December 2003.

Figure 3 shows scattering diagram for the same directions, but based on 1 min. data. Here we really see the ”noice”. We also see a larger displacement for wind from east compared with wind from north.

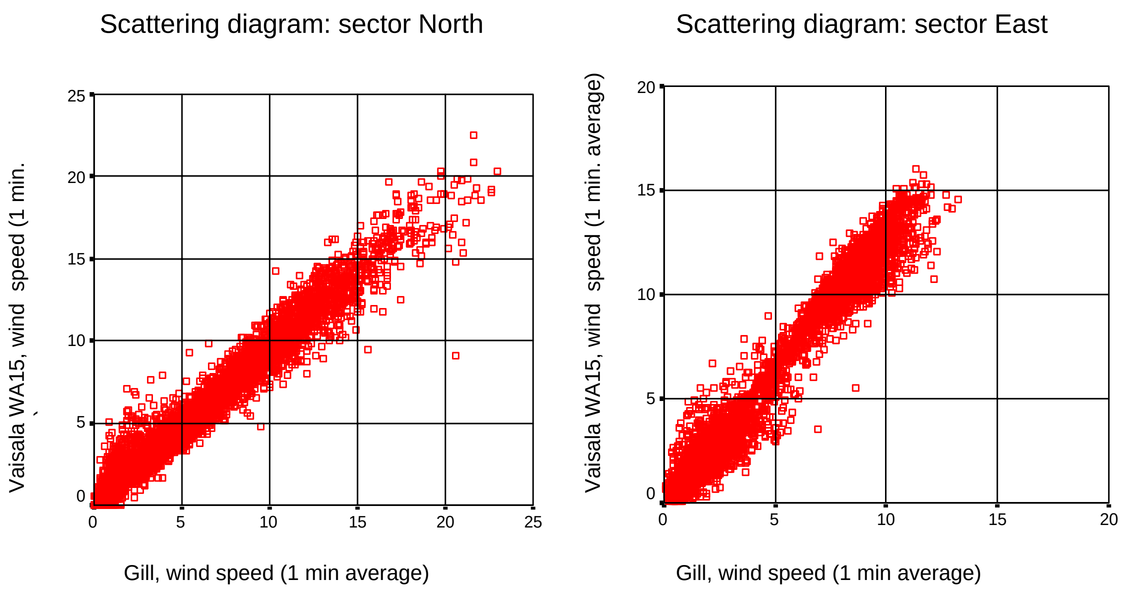


Figure 3: Scattering diagram for the Gill sensor and the Vaisala WA15 sensor based on 1 min data from sector North (N) and East (E) for the period August - December 2003.

Vaisala WS 425

Figure 4 shows the 24 hour average of the wind speed for Vaisala WA15 and Vaisala WS425 based on 1 min. data for the period August – December 2003. There are periods were data is missing from Vaisala WS425. In periods with comparable data (see the figure) the difference between the two sensors is small.

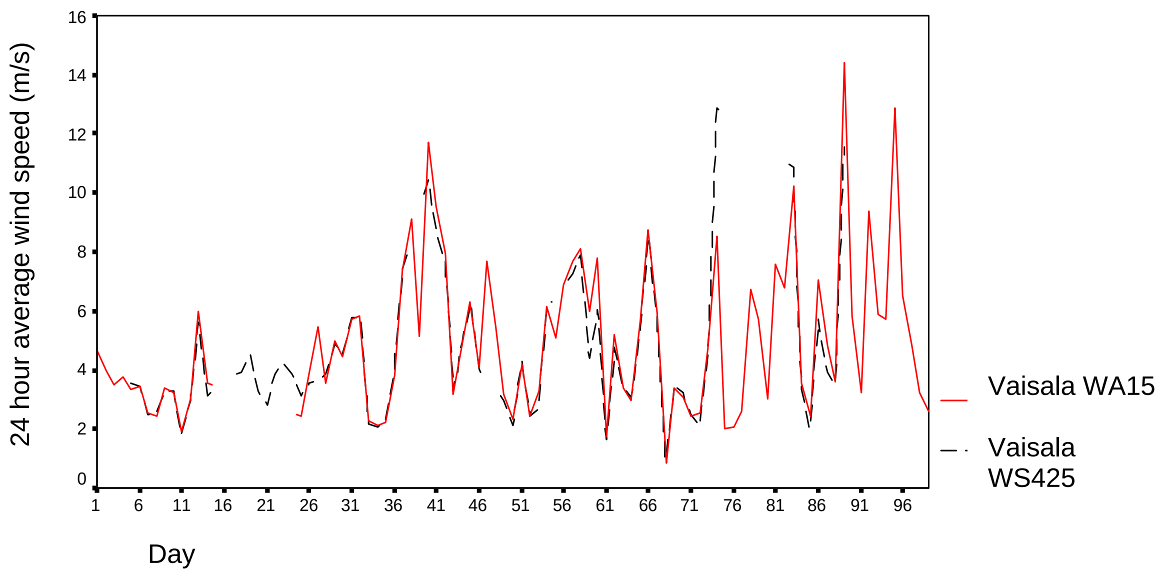


Figure 4: The 24 hour average of the wind speed for the Vaisala WA15 sensor and the Vaisala WS425 sensor based on 1 min. data (August – December 2003).

In table 4 is the difference in wind speed between Vaisala WS425 and Vaisala WA15 is shown for each month based on 1 min data. Notice that it is much less measurements from Vaisala WS425 than from Vaisala WA15. The total values (average: -0,17 and st. devation: 1,17) are not so good as for the 1 min values for Gill – Vaisala WA15 (average: -0,06 and st. deviation: 0,99), but the difference is not very big.

Table 4. Difference in wind speed between Vaisala WS425 and Vaisala WA15 (1 min. data).

Month	Number of measurements	Average	Minimum	Maximum	Standard deviatopn
August	17711	-0,09	-8,80	7,04	1,00
September	10985	-0,21	-8,63	4,71	1,09
October	12646	-0,15	-10,33	7,57	1,20
November	13587	-0,11	-7,33	5,10	1,01
December	12784	-0,35	-10,50	9,34	1,52
Total	**67713**	**-0,17**	**-10,50**	**9,34**	**1,17**

Table 5 shows the difference in wind speed between Vaisala WS425 and Vaisala WA15 at different wind directions based on 1 min data. The standard deviations varies a bit. The lowest value is for wind from north (N) and the highest value is for wind from south-west (SW-WSW). The highest value for wind from south-west is caused by the placement of the Gill sensor in the mast.

Table 5. Difference in wind speed between Vaisala WS425 and Vaisala WA15 for different wind sectors based on 1 min data in the period August – December 2003.

Sector	Number of measurements	Average	Minimum	Maximum	Standard deviation
N	10500	0,14	-6,39	9,34	0,74
NNE	10805	0,06	-5,89	7,04	0,94
NE	5794	-0,15	-4,83	4,37	0,93
ENE	3599	-0,42	-7,33	6,24	0,97
E	3384	-1,00	-8,60	3,97	1,27
ESE	2358	-0,29	-6,46	5,57	0,98
SE	1786	-0,01	-8,63	5,70	0,85
SSE	2175	0,18	-4,60	5,87	0,80
S	1679	0,05	-4,73	6,14	1,06
SSW	4556	0,06	-7,90	5,00	1,11
SW	5962	-0,74	-10,50	7,44	1,78
WSW	2898	-0,99	-10,33	5,57	1,87
W	2020	-0,36	-5,43	5,47	1,19
WNW	2836	-0,32	-8,43	8,41	1,19
NW	3385	-0,01	-6,60	5,07	0,92
NNW	3976	0,11	-6,20	7,70	0,98
TOTAL	**67713**	**-0,17**	**-10,50**	**9,34**	**1,17**

The scattering diagrams for the differences in sector north (N) and south-west (SW) are shown in figure 5. The “noice” can be seen very well in both sectors. The scattering and the displacement are very characeristic for sector SW.

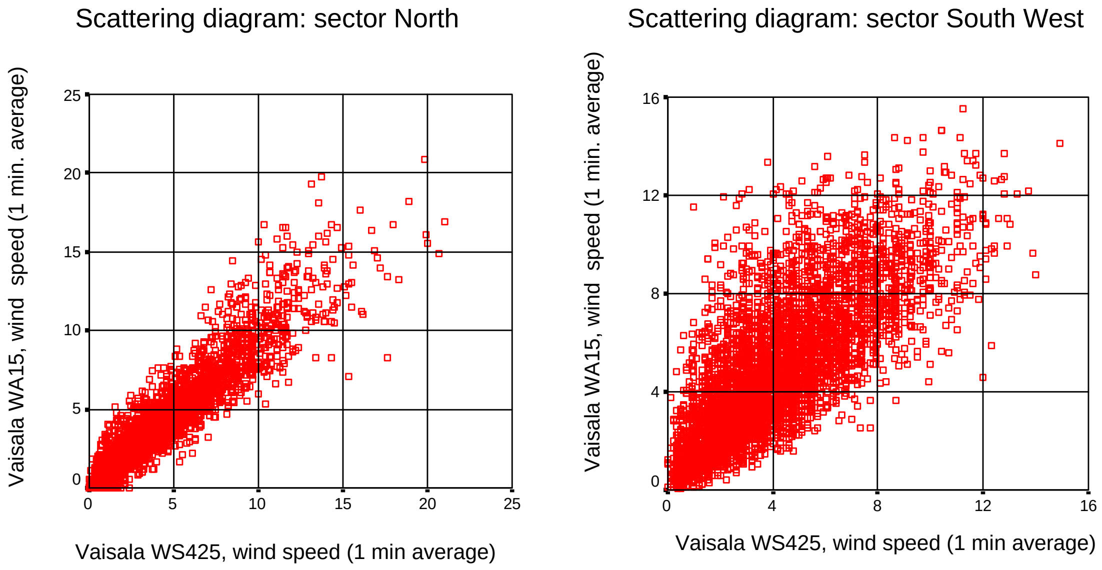


Figure 5: Scattering diagram For the Vaisala WS425 sensor and the Vaisala WA15 sensor base don 1 min data in sector north (N) and sector south west (SW) (august – December).

Difference in wind direction

All the sensors measure wind direction. We use Vaisala WA15 as reference to investigate the difference in wind direction.

Gill Windobserver

Table 6 shows the difference in wind direction between Gill and Vaisala WA15. The wind directions have been divided into 16 sectors. By looking at the average values (table 8) and the raw data (not show here) there is often a positive difference (about 10 degrees) between the two sensors. This might be because the sensors are installed 10 degrees “wrong” compared to each other. It is important to be aware of this difference in analysing the data. Notice the low standard deviation and the average values in the sector SSW/SW. This might confirm our theory that wind from a bigger area (190-270 degrees) is “pressed together” because of the buildings nearby.

Table 6. Difference in wind direction between Gill and Vaisala WA15 for different wind sectors based on 10 min. data in the period August – December 2003.

Sector	Number of measurements	Average	Standard deviation
N	19773	9,52	11,14
NNE	18531	11,03	6,97
NE	8701	11,55	8,44
ENE	8768	10,63	7,16
E	4020	12,64	6,88
ESE	2189	13,82	5,42
SE	1738	13,51	5,47
SSE	3195	13,40	3,97
S	3066	11,59	4,83
SSW	7491	8,68	3,55
SW	13036	5,57	5,24
WSW	3458	6,74	12,34
W	3618	8,58	13,25
WNW	7396	10,03	11,33
NW	5440	10,80	14,66
NNW	6312	8,78	15,61
TOTAL	**116732**	**9,85**	**9,54**

Vaisala WS 425

By looking at only 1 min. data for the difference in wind direction between Vaisala WS425 and Vaisala WA15 the effect of the ”noice” can be seen very well (table 7). The average values vary a lot while the standard deviations are big. Therefore we don’t get much useful information by only have 1 min. data available.

Table 7. Difference in wind direction between Vaisala WS425 and Vaisala WA15 for different wind sectors based on 10 min. data in the period August – December 2003.

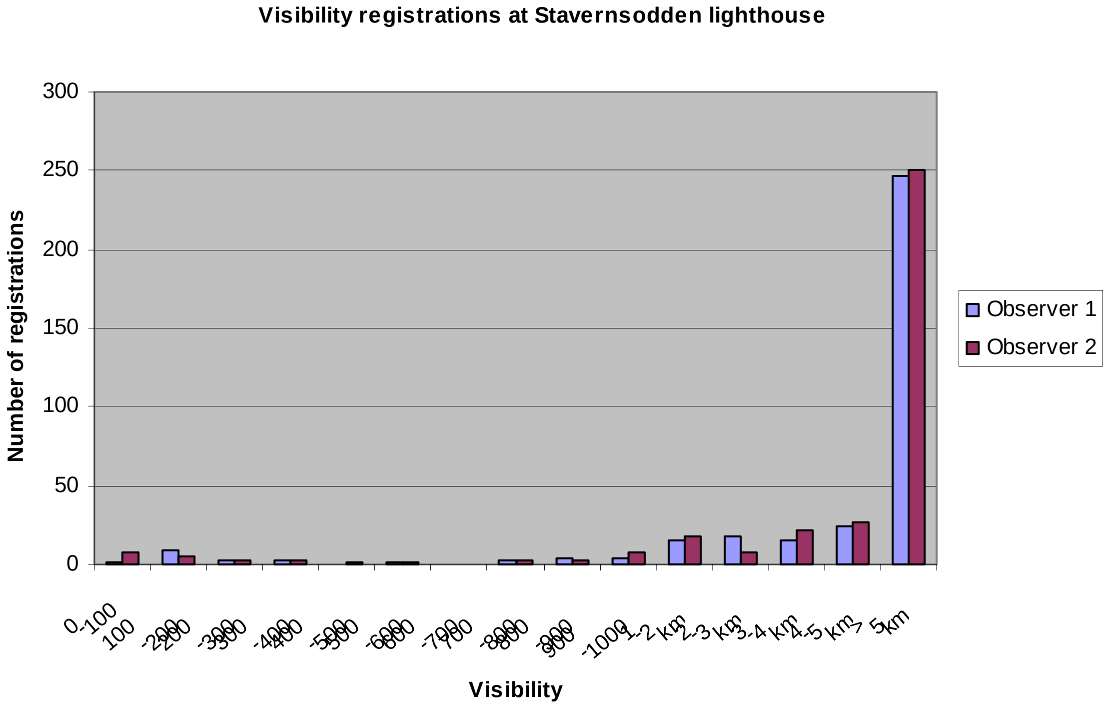
Sector	Number of measurements	Average	Standard deviation
N	10500	15,41	30,98
NNE	10805	11,86	22,78
NE	5794	17,53	31,91
ENE	3599	25,40	39,05
E	3384	24,54	38,65
ESE	2358	28,24	40,94
SE	1786	31,39	43,43
SSE	2175	23,55	37,43
S	1679	32,58	45,00
SSW	4556	19,84	34,36
SW	5962	23,46	32,35
WSW	2898	36,20	42,26
W	2020	45,09	45,25
WNW	2836	34,58	41,32
NW	3385	24,85	38,59
NNW	3976	18,53	34,85
TOTAL	**67713**	**21,81**	**35,62**

Use of video camera
The test field also includes use of video for registration of visibility. At the top of the lighthouse a camera is installed. One can steer the camera from the Norwegian Meteorological Institute. The visibility points used to decide the visibility are at 100 m, 800 m, 1 km and 5 km. The camera was preprogrammed to move to the visibility points.

In March 2003 the registration of visibility at Stavernsodden lighthouse started and went on to May 2004. Two persons have individually used the camera to decide the visibility at the same time. The visibility registrations have been done 2-4 times every day. Over 350 individual registrations of visibility have been taken during the test period. The registrations have been compared to see if there were any differences.

Comparison of the visibility registrations shows that the differences were negligible between the two observers (figure 7). The biggest/largest differences occur when there is fog and when the visibility is between 1 and 5 km. In this interval there were few visibility points.

Figure 7. Visibility registrations made by two observers (March 2003 – May 2004).



There have been some maintenance problems with the camera. The camera has a steering mechanism so the observers can steer the camera 360 degrees, move it up and down and zoom out and in. The problem has been that the camera's steering system has been locked so the camera couldn't be moved to the visibility points. Problems with this steering has been the most difficult to maintain since personnel from met.no are very seldom at Stavernsodden lighthouse.

The camera lens must be cleaned often because in marine environment it easily come salt and dirt on it. This makes bad pictures and can make the visibility registrations difficult. Other minor problems have been rain, snow and dew on the lens, but this has never been such a huge problem that visibility registrations couldn't be done.